US 20060031314A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0031314 A1**

Brahms et al. (43) **Pub. Date: Feb. 9, 2006**

(54) **TECHNIQUES FOR DETERMINING THE REPUTATION OF A MESSAGE SENDER**

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(21) Appl. No.: **10/857,641**

(22) Filed: **May 28, 2004**

Publication Classification

(51) **Int. Cl.**
G06F 15/16 (2006.01)

(52) **U.S. Cl.** **709/206**

(57) **ABSTRACT**

Techniques are provided for determining a reputation of a message sender by obtaining two or more lists from two or more list providers; determining which lists of the two or more lists indicate the message sender; and determining a reputation score for the message sender based on which lists of the two or more lists indicate the message sender. Techniques are also provided for indicating that a message is unsolicited based on a reputation score.

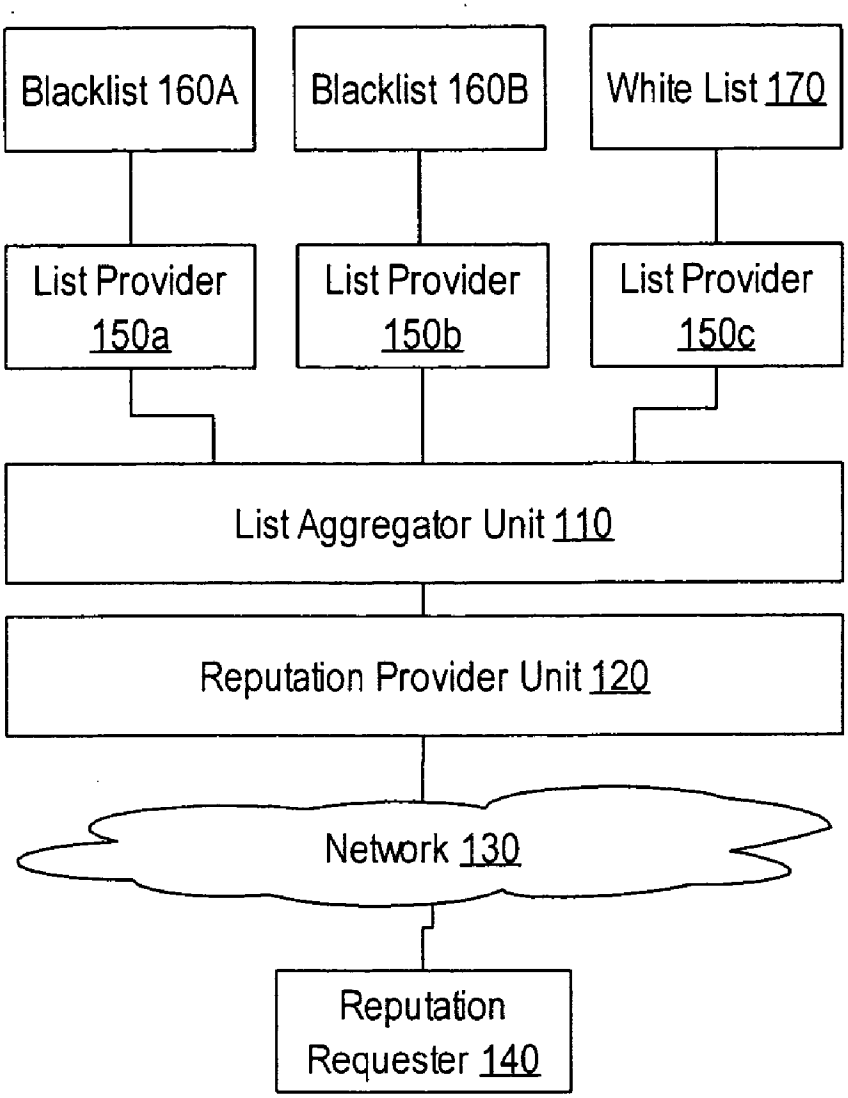


FIG. 1

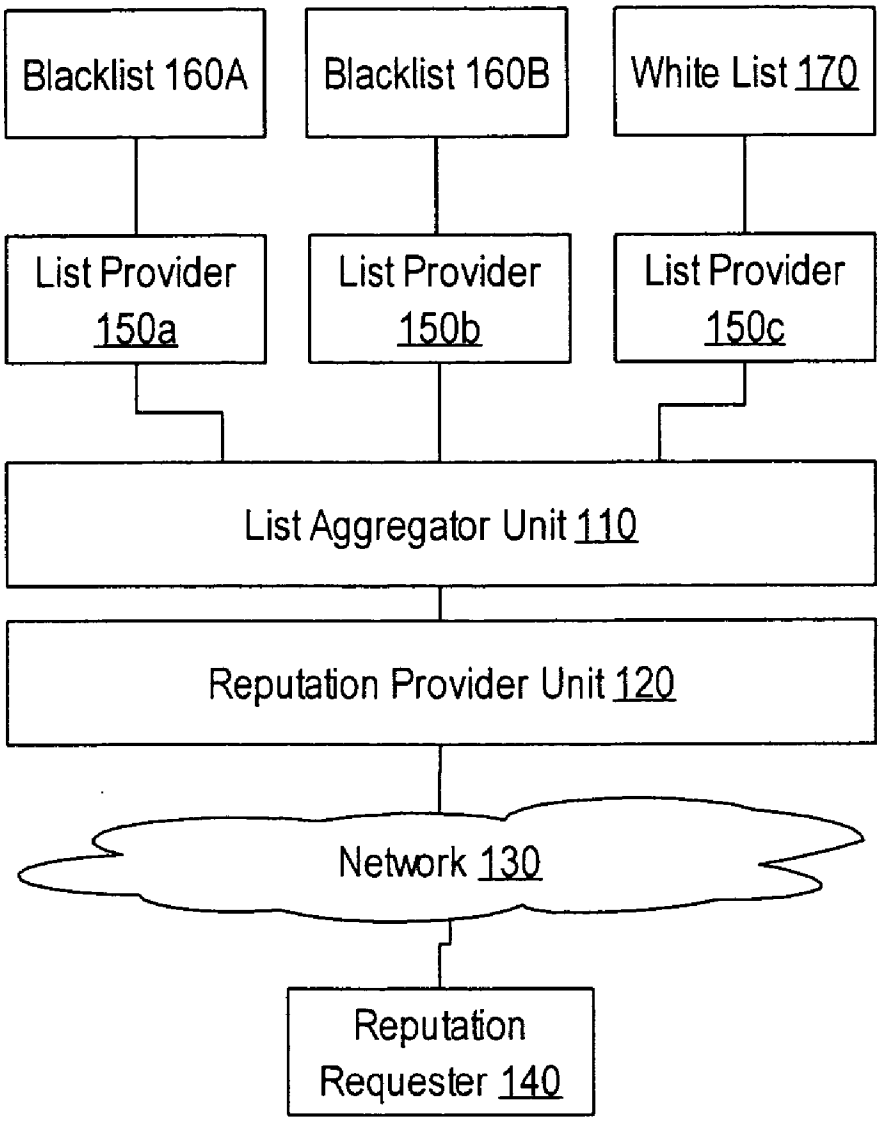

Blacklist 160A
Blacklist 160B
White List 170
List Provider 150a
List Provider 150b
List Provider 150c
List Aggregator Unit 110
Reputation Provider Unit 120
Network 130
Reputation Requester 140

FIG. 2

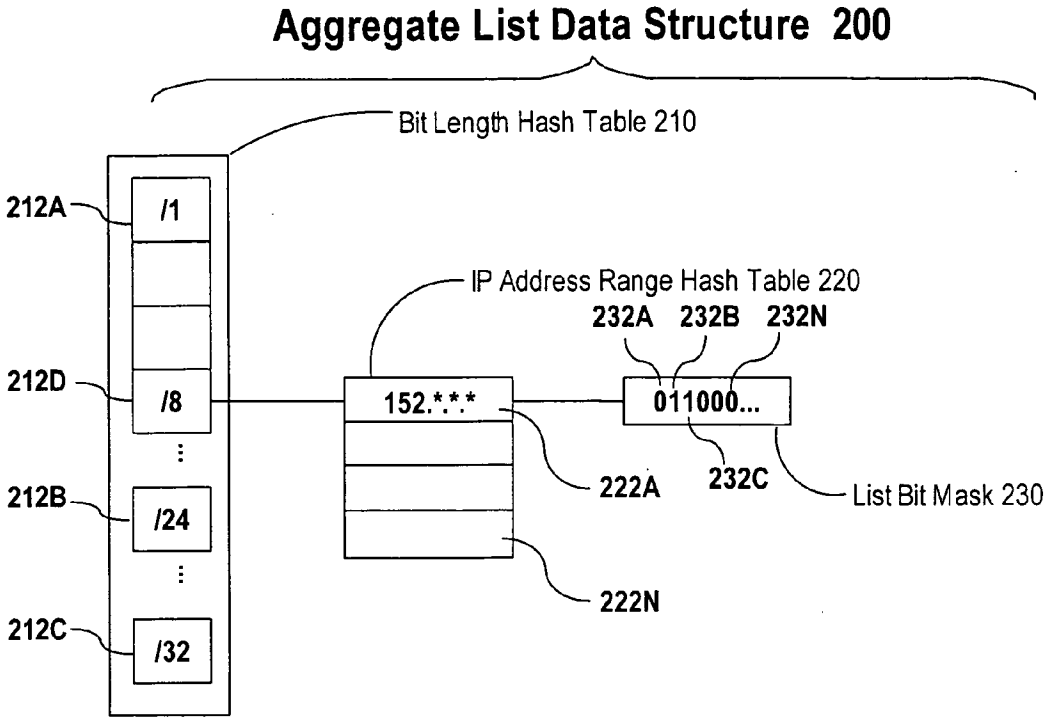

Aggregate List Data Structure 200
Bit Length Hash Table 210
212A
/1
212D
/8
212B
/24
212C
/32
IP Address Range Hash Table 220
232A
232B
232N
152.*.*.*
011000...
222A
232C
List Bit Mask 230
222N

FIG. 3

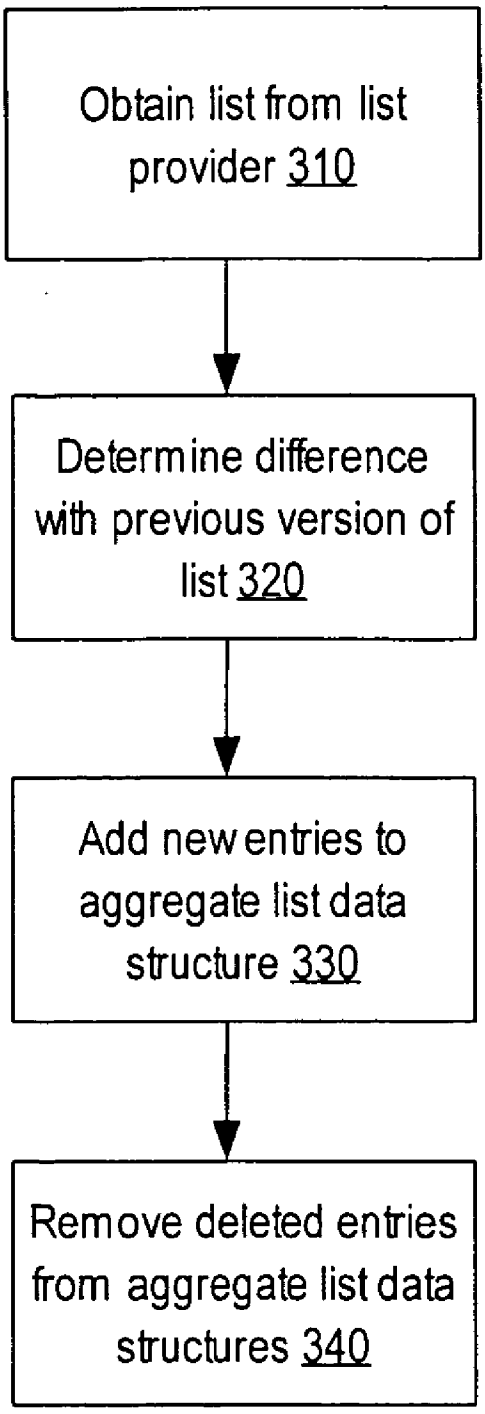

Obtain list from list provider 310
Determine difference with previous version of list 320
Add new entries to aggregate list data structure 330
Remove deleted entries from aggregate list data structures 340

FIG. 4

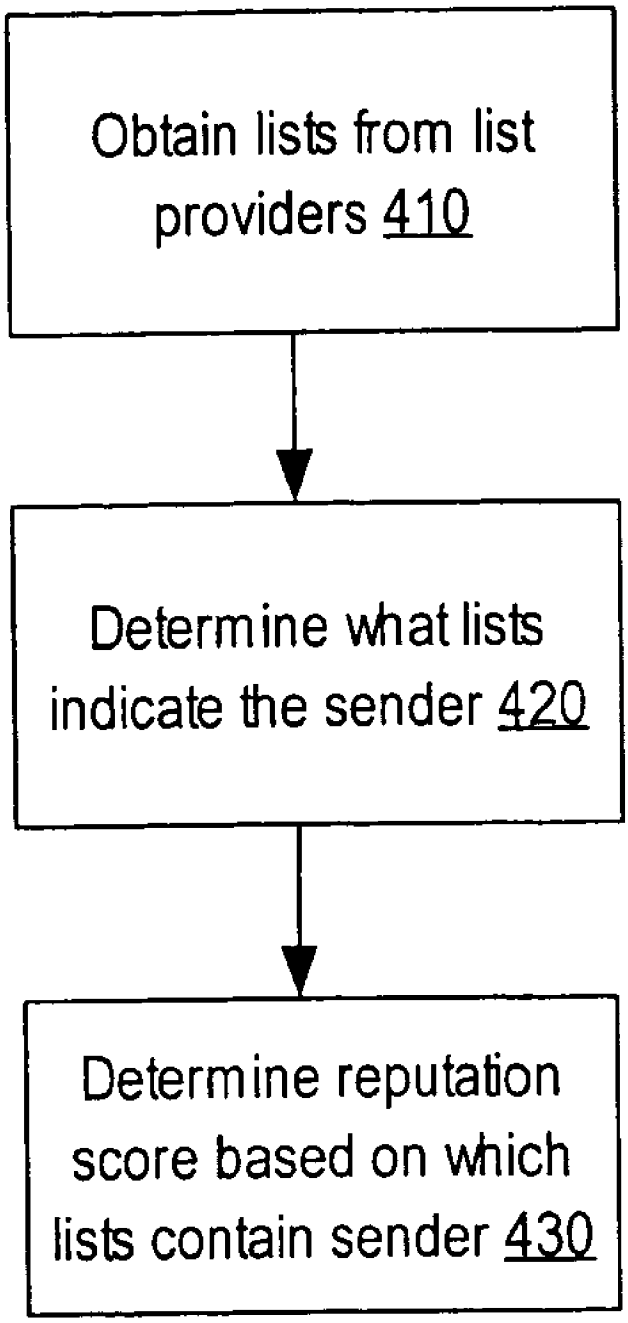

Obtain lists from list providers 410
Determine what lists indicate the sender 420
Determine reputation score based on which lists contain sender 430

FIG. 5

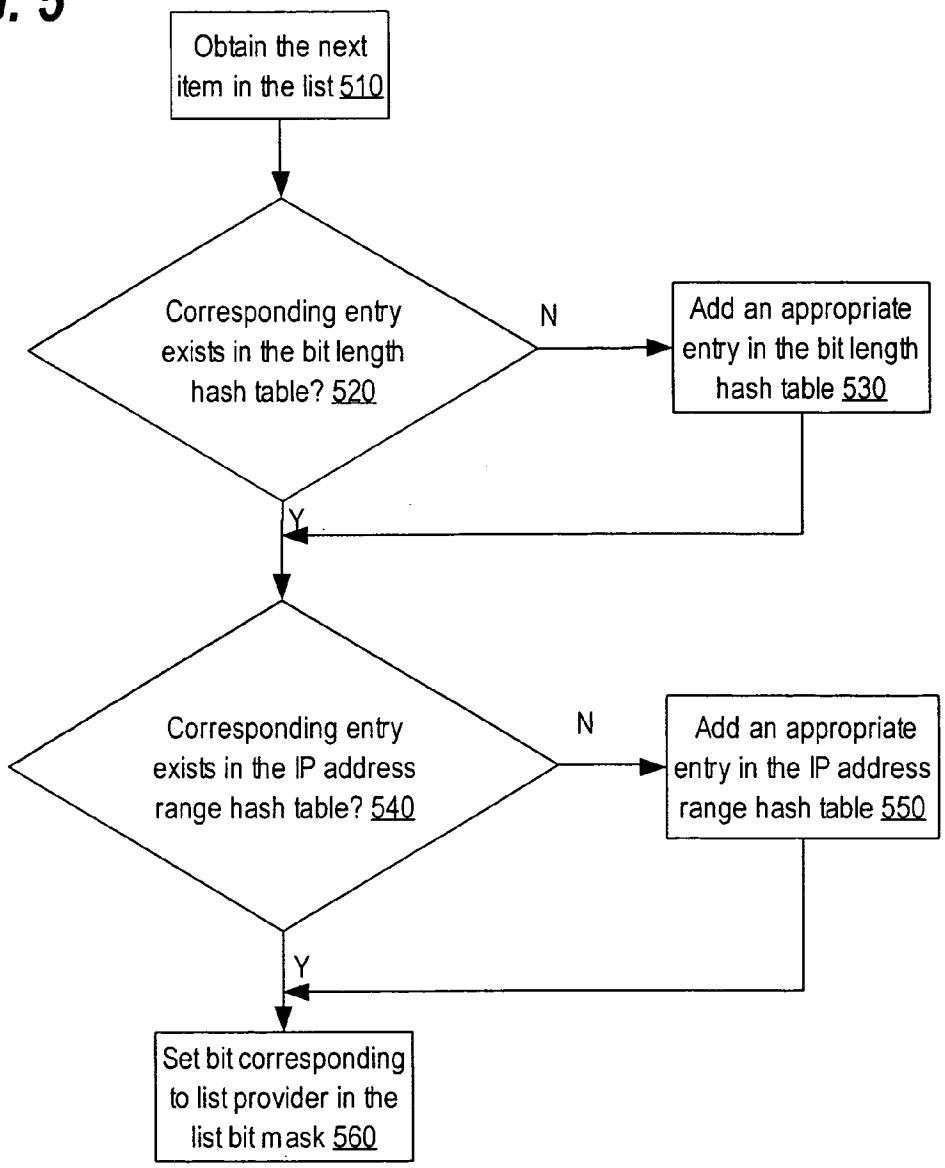

Obtain the next item in the list 510
Corresponding entry exists in the bit length hash table? 520
N
Add an appropriate entry in the bit length hash table 530
Y
Corresponding entry exists in the IP address range hash table? 540
N
Add an appropriate entry in the IP address range hash table 550
Y
Set bit corresponding to list provider in the list bit mask 560

FIG. 6

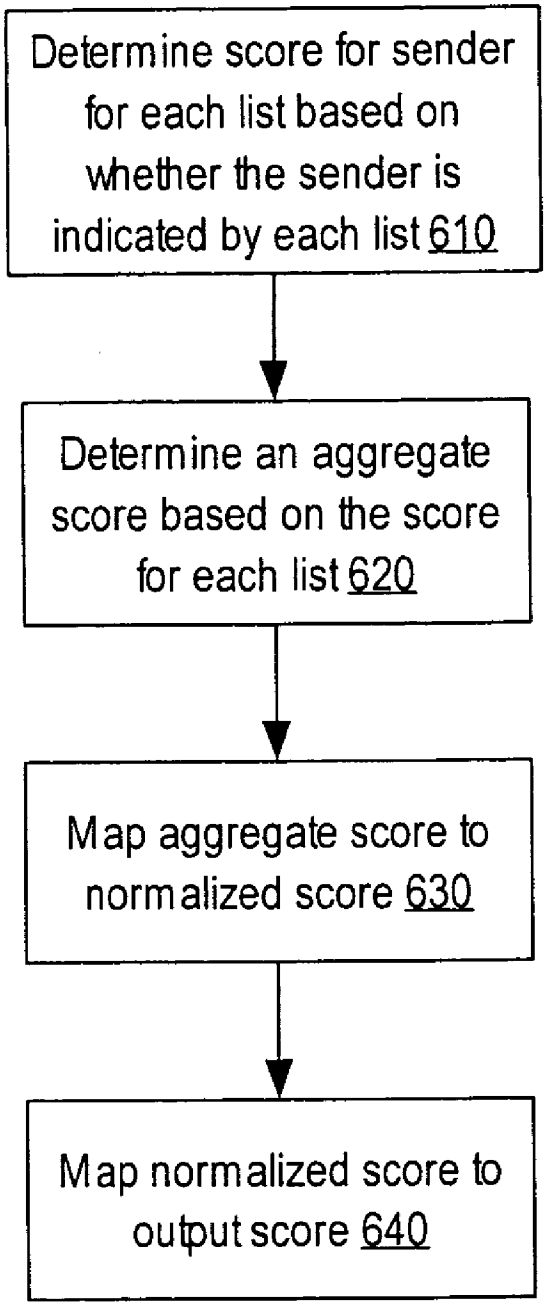
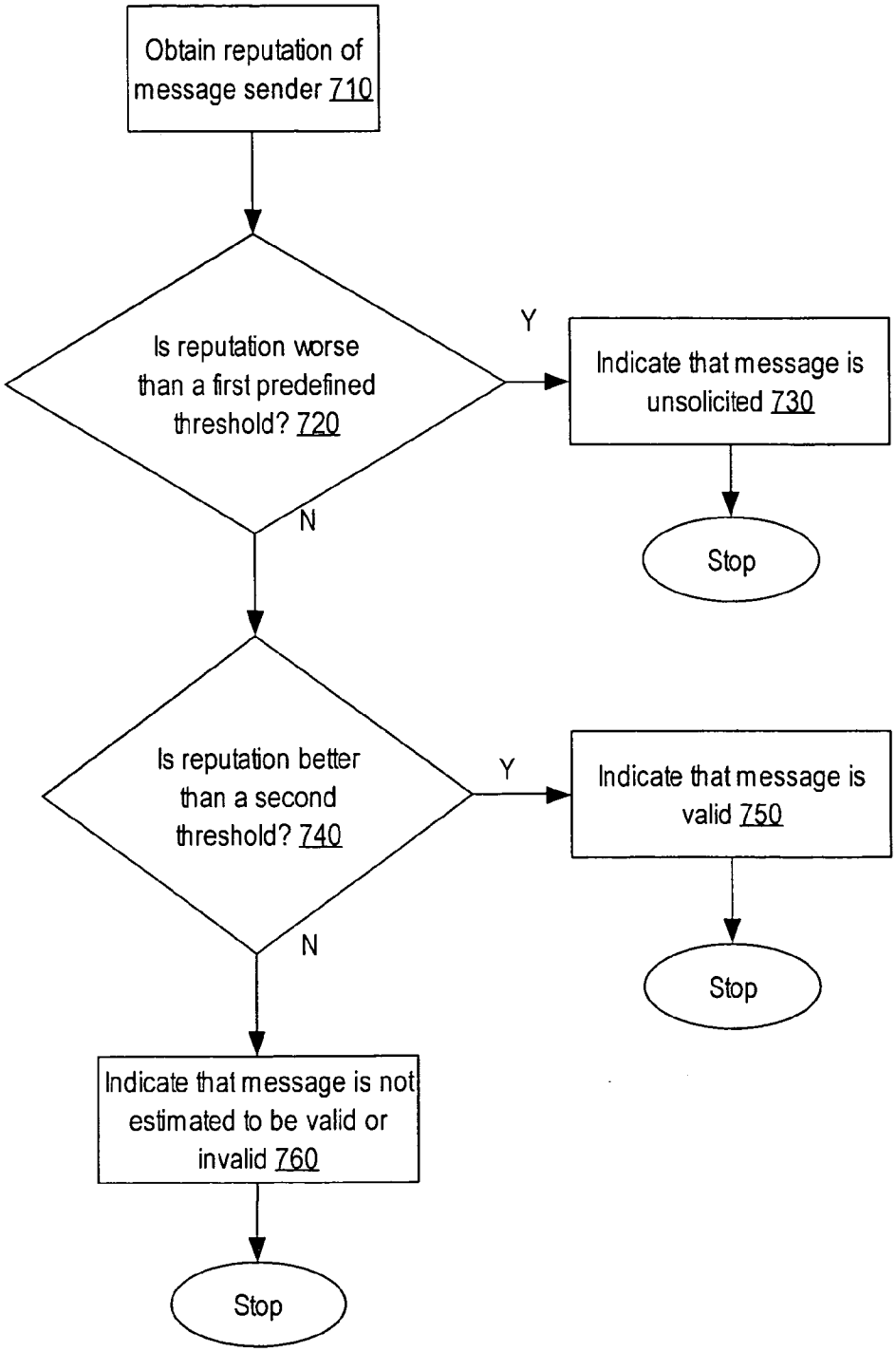

Determine score for sender for each list based on whether the sender is indicated by each list 610
Determine an aggregate score based on the score for each list 620
Map aggregate score to normalized score 630
Map normalized score to output score 640

FIG. 7


Obtain reputation of message sender 710
Is reputation worse than a first predefined threshold? 720
Y
Indicate that message is unsolicited 730
Stop
N
Is reputation better than a second threshold? 740
Y
Indicate that message is valid 750
Stop
N
Indicate that message is not estimated to be valid or invalid 760
Stop

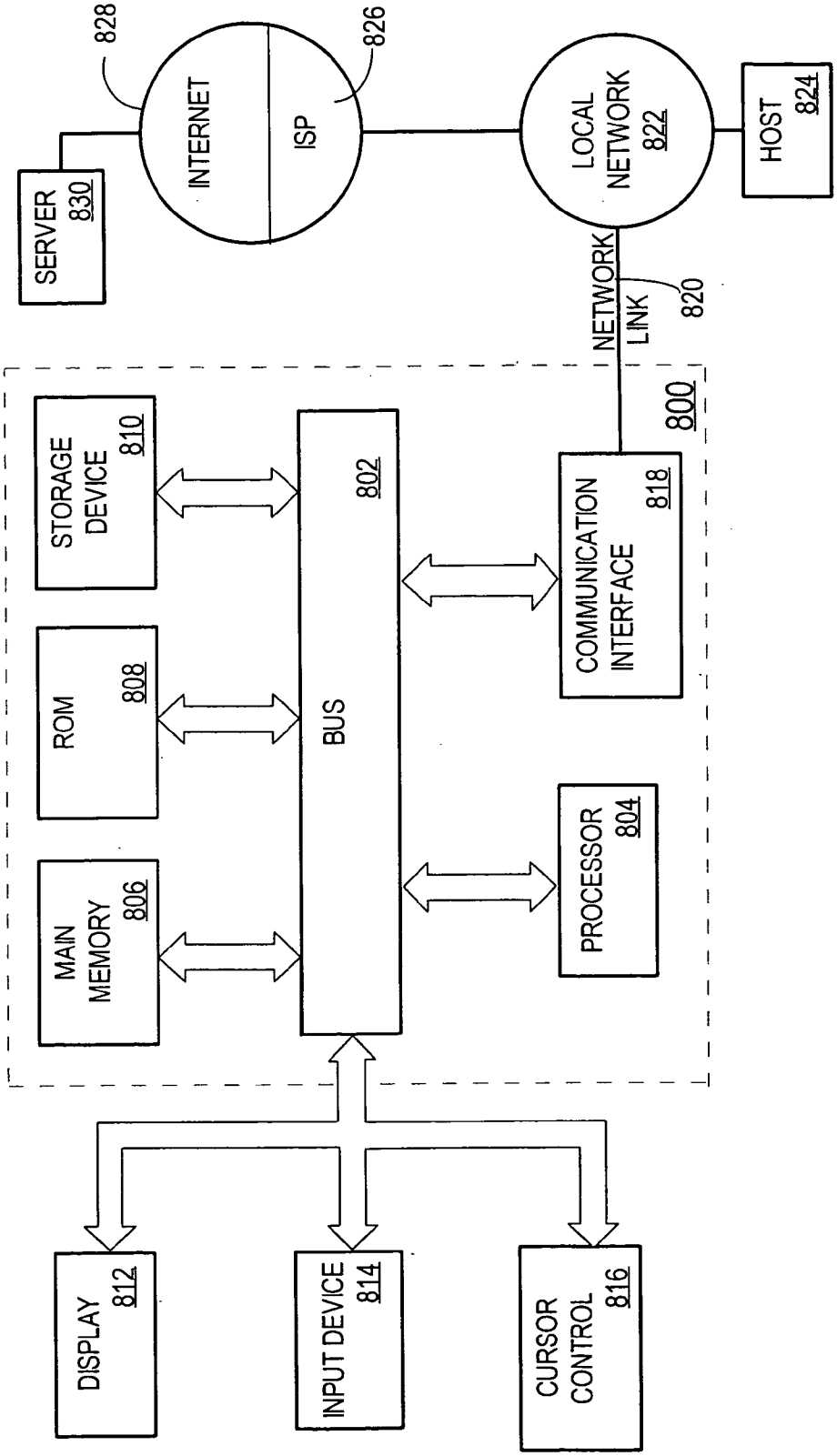

828
INTERNET
ISP
826
LOCAL NETWORK 822
HOST 824
SERVER 830
NETWORK LINK 820
800
STORAGE DEVICE 810
802
COMMUNICATION INTERFACE 818
ROM 808
BUS
MAIN MEMORY 806
PROCESSOR 804
DISPLAY 812
INPUT DEVICE 814
CURSOR CONTROL 816

FIG. 8

TECHNIQUES FOR DETERMINING THE REPUTATION OF A MESSAGE SENDER

RELATED APPLICATIONS PRIORITY CLAIM

[0001] This is related to U.S. Non-Provisional patent application Ser. No. 10/717,441, filed Nov. 18, 2003, naming Banister et al. as inventors, which claims domestic priority under 35 U.S.C. 119 from prior U.S. Provisional Patent application No. 60/428,134, filed Nov. 20, 2002, naming Banister et al. as inventors, and No. 60/482,883, filed Jun. 25, 2003 naming Banister et al. as inventors, the entire contents of which are hereby incorporated by reference for all purposes as if fully set forth herein.

[0002] This application is related to U.S. Provisional patent application No. 60/545,609, filed Feb. 17, 2004, entitled "COLLECTING, AGGREGATING, AND MANAGING INFORMATION RELATING TO ELECTRONIC MESSAGES", naming Flury et al. as inventors, which is hereby incorporated by reference for all purposes as if fully set forth herein.

[0003] This application is related to U.S. Provisional patent application no. _____ (Attorney Docket No. 60063.0039), filed May 25, 2004, entitled "COLLECTING, AGGREGATING, AND MANAGING INFORMATION RELATING TO ELECTRONIC MESSAGES", naming Flury et al. as inventors, which is hereby incorporated by reference for all purposes as if fully set forth herein.

[0004] This application is related to U.S. patent application no. _____ (Attorney Docket No. 60063.0037), filed May 28, 2004, entitled "ELECTRONIC MESSAGE DELIVERY WITH ESTIMATION APPROACHES", naming Perry et al. as inventors, which is hereby incorporated by reference for all purposes as if fully set forth herein.

FIELD OF THE INVENTION

[0005] The present invention generally relates to electronic message delivery in a networked system. The invention relates more specifically to techniques for determining the reputation of a message sender.

BACKGROUND OF THE INVENTION

[0006] The approaches described in this section could be pursued, but are not necessarily approaches that have been previously conceived or pursued. Therefore, unless otherwise indicated herein, the approaches described in this section are not prior art to the claims in this application and are not admitted to be prior art by inclusion in this section.

[0007] The use of electronic message communication systems has increased significantly in the recent past. However, numerous users of such systems, whether they are message senders or receivers, find such systems inconvenient and cumbersome to use. Similar problems are associated with telephone, facsimile, and e-mail communications, and others.

[0008] In the e-mail context, in one past approach, senders marketing commercial products or services would acquire or develop lists of e-mail addresses and then periodically send mass unsolicited e-mail messages ("spam") to all addresses in the lists. Using modern electronic systems, the cost of sending millions of such messages has been negligible, and a response rate of even less than one percent has been considered worthwhile. Thus, successful delivery of unsolicited messages to valid in-boxes of recipients normally translates into income for the sender.

[0009] Unfortunately, this approach causes receivers to receive unwanted messages. The direct and indirect costs of receiving "spam" are high. In response, receivers have adopted a variety of approaches to prevent receipt or viewing of unwanted messages.

[0010] In one approach, receivers use filtering, marking, or blocking technologies that attempt to classify messages as "spam" or not spam by examining various aspects of the message. For example, some filters look for keywords in the message subject line and reject or quarantine messages that contain keywords matching a list of prohibited words. In another approach, receivers use "blacklists" to identify and prohibit or less easily admit messages from suspect senders of unsolicited messages. Some receivers augment these technologies with personal "white lists" of friends or other acceptable senders; messages from senders in the white list are admitted or more easily admitted. The white lists and blacklists also may come from networked sources. Techniques for performing blacklist lookups are described at the document "ip4r.htm" that is available online at the time of this writing at directory "/junkmail/support/" of the "declude.com" domain of the World Wide Web, and www.sconsult.com/bill/. Example blacklists include the series of blacklists provided by njabl.org. Example white lists could include lists of Fortune 500 companies and other reputable senders.

[0011] One problem with these approaches is that some messages that receivers want may not reach the intended receivers because they are identified as "spam" by the filtering or blocking technologies. Receivers who use filtering or blocking technologies regularly fail to receive some legitimate messages because the filtering and blocking technologies cannot always properly distinguish legitimate messages from unsolicited messages. For example, certain industry-standard terms or technical abbreviations may be identical to prohibited keywords, confusing the "spam" filter.

[0012] Further, receivers continue to receive large volumes of unwanted messages that are not properly trapped by the "spam" filter. As a result, many receivers now refuse to disclose their address except under limited circumstances. In response, many legitimate senders, such as reputable commercial enterprises, have developed "opt-in" procedures in which the addresses of receivers, such as customers, are not used at all unless the receiver affirmatively agrees to receive messages. Even when this is done, the filtering or blocking technologies may delete or quarantine even those messages from legitimate senders that are directed to receivers who have "opted in." Consequently, the value of e-mail as a marketing tool for responsible communications directed to receivers who have "opted in" is decreasing. Many receivers remain essentially defenseless to the daily onslaught of "spam" arriving in their e-mail in-boxes. Whereas many states have enacted legislation that imposes civil or criminal penalties for sending "spam," these remedies are time-consuming for receivers to pursue. In addition, while many Internet Service Providers ("ISPs") actively identify and refuse to communicate or do business with those who send

"spam," however, policing such improper activity imposes a significant cost on the ISP. In addition, ISPs are burdened with the aggregated network and disk usage costs associated with the sending and receiving the unwanted messages. End users may also be burdened with bandwidth costs associated with downloading these messages.

[0013] ISPs also incur costs associated with processing messages directed to recipients who do not hold an account with the ISP. For these recipients, the ISPs mail system typically generates an automatic "bounce" message that states that the recipient is unknown. Indeed, a "double bounce" may occur when a message bears an invalid sender address, and is sent to an invalid recipient. Costs are associated with maintaining the equipment, network bandwidth, and software that generates the bounce messages and for dispatching the bounce messages back into the network to the sender. Thus, there is a need for a system or method that can reduce the number of "bounce" and "double bounce" events experienced by ISPs and derived from unwanted messages.

[0014] Thus, the problem of "spam" in the Internet e-mail context is essentially a war of attrition. There are legitimate marketing organizations that send promotional messages by bulk e-mail, and other senders who send valid bulk messages. In general, however, no one benefits from the activities of "spammers," other than the "spammers" themselves. ISPs, business enterprises, and end users all suffer inconvenience, costs, and annoyances.

[0015] Even when ISPs and enterprises use anti-"spam" technologies, large numbers of "spam" messages may not be identified as spam, and many non-spam messages may be misclassified as spam. This costs e-mail marketers, and causes senders to lose confidence in the benefits of e-mail marketing. Moreover, end users are required to invest time in monitoring, checking, delivering, and negotiating blacklists, white lists, and similar mechanisms. The information from these lists can be conflicting, and therefore making a decision for a particular email sender based on the information in these lists can be difficult.

[0016] While the foregoing example problems exist in the context of e-mail, instant messaging, chat-room applications, Web message boards, telephone, and facsimile communications suffer from analogous problems.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

[0018] **FIG. 1** is a block diagram that illustrates an overview of a system for determining the reputation of a message sender.

[0019] **FIG. 2** is a block diagram of an example data structure that can be used in determining the reputation of a message sender.

[0020] **FIG. 3** is a flow diagram that depicts a method of maintaining an aggregate list of individual reputation-related lists;

[0021] **FIG. 4** is a flow diagram that depicts a method of determining the reputation of a message sender.

[0022] **FIG. 5** is a flow diagram that depicts a process for adding entries to an aggregate list data structure.

[0023] **FIG. 6** is a flow diagram that depicts an example embodiment of determining a reputation score based on which lists indicate the sender.

[0024] **FIG. 7** is a flow diagram that depicts a process for estimating whether a message is unsolicited.

[0025] **FIG. 8** is a block diagram that illustrates a computer system upon which an embodiment of the invention may be implemented

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] Techniques for determining the reputation of a message sender are described. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the present invention.

[0027] Embodiments are described herein according to the following outline:

[0028] 1.0 General Overview

[0029] 2.0 Structural Overview

- [0030] 2.1 Example System Organization
- [0031] 2.2 Sample Data Structure

[0032] 3.0 Functional Overview

- [0033] 3.1 Maintaining Aggregate Lists
- [0034] 3.2 Adding Entries to an Aggregate Data Structure
- [0035] 3.3 Example Reputation Score Calculations
- [0036] 3.4 Example Process for Estimating Whether a Message is Unsolicited

[0037] 4.0 Implementation Mechanisms-Hardware Overview

[0038] 5.0 Extensions and Alternatives

1.0 General Overview

[0039] The needs identified in the foregoing Background, and other needs and objects that will become apparent for the following description, are achieved in the present invention, which comprises, in one aspect, a method for determining the reputation of a message sender. In other aspects, the invention encompasses a computer apparatus and a computer readable medium configured for determining the reputation of a message sender.

[0040] Generally, herein are provided techniques by which message receivers can determine the reputation of a message sender by obtaining two or more lists from two or more list providers; determining which lists of the two or more lists indicate the message sender; and determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender.

[0041] In a related feature, the techniques further include the step of storing information from the two or more lists in an aggregate list data structure, and where the step of determining what lists indicate the message sender includes the step of querying the aggregate list data structure. In a related feature, a particular list is one of the two or more lists and the particular list contains one or more entries, and where the step of storing information from the two or more lists in the aggregate list data structure includes the steps of determining the difference of the particular list with a previous version of the particular list; storing entries of the particular list that were not in the previous version of the particular list in the aggregate list data structure; and removing from the aggregate list data structure entries that are not in the particular list but were in the previous version of the particular list.

[0042] In a related feature, the step of determining the reputation score includes the steps of determining an individual score for each list of the two or more lists; and determining an output score based on the individual score for each list in the two or more lists. In a related feature, the step of determining the output score includes the steps of determining an aggregate score based on the individual score for each list of the two or more lists; determining a normalized score based on the aggregate score; and determining the output score based on the normalized score.

[0043] In a related feature, the individual score for each list in the two or more lists each includes an individual probability and a list of probabilities includes the individual probability for each list in the two or more lists, and where the step of determining the aggregate score based on the individual score for each list of the two or more lists includes performing a Chi Squared calculation on the list of probabilities. In a related feature, the techniques further include the step of receiving a request for the reputation of the message sender. In a related feature, the step of receiving the request for the reputation of the message sender includes receiving a request formatted as a DNS request. In a related feature, the message sender is associated with a particular IP address and the step of determining what lists of the two or more lists indicate the message sender includes determining for a particular list of the two or more lists whether the particular IP address of the message sender is contained in an IP address range indicated by the particular list. In a related feature, the techniques further include, if a particular list indicates an IP address range, setting a bit corresponding to the particular list in a particular list bit mask data structure corresponding to the IP address range.

[0044] In a related feature, the step of setting the bit corresponding to the particular list is performed for each list of the two or more lists, and where sender corresponds to a particular IP address, the particular IP address is contained within a first IP address range that has associated with it a first list bit mask, the IP address is contained within a second IP address range associated with a second list bit mask, and the method further includes the step of determining which lists of the two or more lists indicate the message sender by performing the steps of performing an or operation on the first list bit mask and second list bit mask to produce a third list bit mask; and determining what bits are set in the third list bit mask.

[0045] In another aspect techniques are provided for receiving a message from a message sender; obtaining a reputation score of the message sender, where the reputation score of the message sender was determined by performing the steps of obtaining two or more lists from two or more list providers; determining which lists of the two or more lists indicate the message sender; determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender; and if the reputation score is worse than a first predefined threshold, indicating that the message is unsolicited.

[0046] In a related feature, the techniques further include the step of, if the reputation score is better than a second predefined threshold, indicating that the message is valid, where the first predefined threshold is different from the second predefined threshold. In a related feature, the techniques further include the step of if the reputation score is better than the first predefined threshold and worse than the second predefined threshold, indicating that the message is not estimated as either valid or invalid. In a related feature, the techniques further include the step of sending a request for the reputation score of the message sender, and where the step of obtaining the reputation score of the message sender includes receiving a response to the request for the reputation score of the message sender. In a related feature, the step of sending the request for the reputation score of the message sender includes sending a particular request formatted as a DNS request.

[0047] In other aspects, the invention encompasses a computer apparatus and a computer-readable medium configured to carry out the foregoing steps.

2.0 Structural Overview

2.1 Example System Organization

[0048] **FIG. 1** is a block diagram that illustrates an overview of a system for determining the reputation of a message sender.

[0049] A list aggregator unit **110** is communicatively coupled to two or more list providers **150**. In the example shown, the list aggregator unit **110** is communicatively coupled to three list providers **150***a*, **105***b*, **150***c*. The list aggregator unit **110** is also communicatively coupled to a reputation provider unit **120**. The reputation provider unit **120** is communicatively coupled to a network **130**. A reputation requester **140** is also communicatively coupled to the network **130**. In various embodiments, the network **130** is a wireless network, dial up access, the Internet, a LAN, a WAN, or any other communication network.

[0050] The list aggregator unit **110** and reputation provider unit **120** are each logical machines. Logical machines may comprise one or more computer programs or other software elements. Each logical machine may run on separate physical computing machines or may run on the same physical computing machine as one or more of the other logical machines. Various embodiments of computers and other physical computing machines are described in detail below in the section entitled Hardware Overview.

[0051] The reputation requester **140** can be any appropriate machine, user, or process capable of communicating a request over a network. For example, in one embodiment, a reputation requester **140** is a mail server running on a computer that has a network interface, and the mail server is capable of formulating a request for the reputation of an

electronic message sender. In other embodiments, the reputation requestor **140** could be any **212**C, **212**D is only added to the bit length hash table **210** if a range of IP addresses corresponding to that length is received in one of the reputation-related lists.

[**0052**] There is one IP address range hash table **220** for each key **212**A-D in the bit length hash table **210**. Each IP address range hash table **220** has a key **222**A-N for each IP address range of the particular range length that is received from a list provider. For example, if two "/8" IP address ranges "152.*.*.*" and "159.*.*.*" were received from one or more list providers as part of one or more reputation lists, then two keys would be added to the IP address range hash table for /8: one corresponding to each of "152.*.*.*" and "159.*.*.*".

[**0053**] There is a list bit mask **230** corresponding to each entry **222**A-**222**N in the IP address range hash table **220**. The list bit mask **230** records which black or white lists include the IP address or range value of the entry **222**A-**222**N that reference the list bit mask **230**. In one embodiment, each list provider **105***a*-**150***c* a corresponding bit **232**A-**232**N in the list bit mask **230**. In another embodiment, two or more list providers **105***a*-**150***c* correspond to a single bit **232**A-**232**N. In yet another embodiment, one list provider **150***a* corresponds to one or more bits **232**A-**232**N. For simplicity in explanation, in the examples herein each list provider **150***a*-**150***c* corresponds to a single bit **232**A-**232**N. In one embodiment, if a list indicates or includes a particular IP address range of an entry **222**A-**222**N, then a bit corresponding to that list is set to "1".

[**0054**] As an example, in the context of **FIG. 1**, consider a list provider **150***a* corresponding to bit **232**C and a list provider **150***b* corresponding to bit **232**B. If both list provider **150***a* and list provider **150***b* each provide a list that includes a /8 entry of "152.*.*.*" then bits **232**C, **232**B are set to "1". The rest of the bits in the list bit mask default to zero. If subsequently list provider **150***c* (corresponding to bit **232**A) provides a list mechanism requesting reputation information for a mail sender including an access server, gateway, firewall, mail transfer agent, mail client, mail filtering mechanism, etc.

[**0055**] The list providers **150***a*, **105***b*, **150***c* are any appropriate mechanism for providing lists **160***a*, **160***b*, **170** related to reputations of mail senders. For example, in one embodiment, the list providers **150***a*, **105***b*, **150***c* are modified domain name servers (DNSs) running on computers with network interfaces that are capable of providing lists **160***a*, **160***b*, **170** related to reputations of mail senders. In other embodiments, each of the list providers **150***a*, **105***b*, **150***c* is a FTP server, HTTP server, or any other appropriate mechanism capable of providing lists **160***a*, **160***b*, **170** related to reputations of mail senders.

2.1 Sample Data Structure

[**0056**] **FIG. 2** is a block diagram of an example data structure that can be used in determining the reputation of a message sender.

[**0057**] The aggregate list data structure **200** is an example of a data structure that can be used to efficiently store and provide information related to multiple mail senders. The techniques described herein are in no way limited to the use of this particular data structure. Any appropriate data structure or data set stored in a machine-readable medium could be used to store reputation information from multiple lists.

[**0058**] The aggregate list data structure **200** comprises a bit length hash table **210**, an IP (Internet Protocol) address range hash table **220** as the value for each key in the bit length hash table **210**, and a list bit mask **230** as the value for each key in the IP address range hash table **220**. Although the example of **FIG. 2** is illustrated for use with IP addresses, other embodiments may be used with other network address mechanisms or other appropriate identifiers, such as domain name, email address, geographical location, or any appropriate identification mechanism.

[**0059**] The use of the aggregate list data structure **200** is described in more detail below. However, a brief description is instructive as to its structure. The aggregate list data structure **200**, as the name suggests, provides a single data structure in which reputation data from multiple reputation lists can be stored. In various embodiments, a reputation list can contain a positive or negative association with a single IP address or a range of IP addresses. In other embodiments, reputations are associated with something other than IP address, such as domain name, email address, geography, or any other appropriate value. For simplicity in explanation, in the examples given herein, reputations will be described as being associated with IP addresses and ranges.

[**0060**] A reputation list **160***a*, **160***b*, **170** from a reputation list provider **150***a*, **150***b*, **150***c* could take on any appropriate form such as a blacklist of IP addresses and ranges that indicate IP addresses from which electronic messages have a high likelihood of being unsolicited electronic messages, white lists of IP addresses that indicate IP addresses and ranges from which there is a low likelihood of an unsolicited electronic messages being sent, or any other appropriate types of lists.

[**0061**] The keys **212**A, **212**B, **212**C, **212**D in the bit length hash table **210** represent the length of defined significant digits of an IP address range associated with a reputation. Typically, IP addresses are 32 bits long, so the range of possible entries for a 32 bit IP address would be from /0 (no significant bits are defined) to /32 (all the bits are defined). For example, "/8" refers to a range where only the first eight bits are defined and is associated with key **212**D. An example /8 entry could be "152.*.*.*" (where "*" represents a wildcard and signifies that the corresponding bits are not defined). IP addresses "152.2.128.152" and "152.123.234.4" would fall into the /8 range of "152.*.*.*". The IP address "153.2.128.152" would not fall into the /8 range of "**152**.*.*.*". In one embodiment, a key **212**A, **212**B, that does not include "152.*.*.*", then bit **232**A will not be set to one, but will remain zero. Therefore the first three bits of the list bit mask **230** would read "011" as shown in **FIG. 2**.

3.0 Functional Overview

3.1 Maintaining Aggregate Lists

[**0062**] **FIG. 3** is a flow diagram that depicts a method of maintaining an aggregate list of individual reputation-related lists.

[**0063**] In various embodiments, one or more reputation lists are provided by reputation list providers. In one embodiment, system initialization includes determining at what interval updates to the lists will be obtained or deter-

mining what will trigger obtaining updates to the lists. In a related embodiment, determining when to obtain updates to the lists is based on how often a list is updated. For example, a blacklist of IP addresses could be known to be updated every few seconds, minutes, hours, days, weeks, etc., and obtaining updates to the list could be based on that known updating frequency. In various embodiments, the updating of the list is signaled by the list provider, is detectable by the list aggregator unit, or is otherwise signaled or detectable.

[0064] The steps of **FIG. 3** are performed for each list of one or more lists from one or more list providers. In various embodiments, the lists from different list providers are obtained at different times or are obtained at the same time. The description of **FIG. 3** below will discuss maintaining a single list from a single list provider.

[0065] In step **310**, a particular list is obtained from a list provider. The particular list can be obtained in any number of ways. In various embodiments, the particular list is obtained using a DNS zone transfer; database export and later import; obtaining a file containing the list by file transfer protocol (FTP), hypertext transfer protocol (HTTP), secure HTTP (HTTPS), or the rsync protocol; or any other appropriate means. In various related embodiments, the step **310** of obtaining a list is initiated by a signal from the list processor or by the detection of the change in the list. In various embodiments, the step **310** of obtaining a list is initiated after a predefined period of time. In a related embodiment, the predefined period of time to wait before obtaining the list is based on a predetermined schedule of updates to the list.

[0066] A particular list obtained from a list provider can take any appropriate form. An example of an appropriate form could be a list of IP address ranges and IP addresses. For example, in the context of **FIG. 1**, a list aggregator unit **110** obtains a list **160**A from a list provider **150***a* via DNS zone transfer and the list is in the form of a blacklist of IP addresses and IP address ranges.

[0067] In step **320**, the difference between the current version of the particular list and any previous version of the particular list is determined. In one embodiment, if there is no previous version of the particular list then the difference between the particular list obtained in step **310** and "the previous list" is defined as the full list obtained in step **310**. In various embodiments, if there is a previous version of the particular list, the difference between the version of the particular list obtained in step **310** and the previous version of the particular list is determined by using any appropriate tool, such as the Unix "diff" command, for example.

[0068] As noted above, there are numerous possible embodiments for the aggregate list and, therefore, there are numerous possible embodiments for steps **330** and **340**. Steps **330** and **340**, for sake of clarity of description, will be described in terms of data structures similar to the aggregate list data structure **200** of **FIG. 2**.

[0069] In step **330**, the new entries are added to the aggregate list data structure. An example method for adding entries to an aggregate list data structure is depicted in and described herein with respect to **FIG. 5**.

[0070] When an entry is deleted from a particular list, its corresponding entries must be deleted from the aggregate list data structure as part of step **340**. Deleting an entry from an aggregate list data structure can be accomplished by finding the IP address range hash table associated with the appropriate length entry in the bit length hash table; finding the list bit mask associated with the appropriate entry in the IP address range hash table; and setting the bit in the list bit mask corresponding to the particular list to "0". For example, in the context of **FIG. 2**, the entry "152.*.*.*" is deleted from the aggregate list data structure **200** by finding the "/8" entry **212**D in the bit length hash table **210**, finding the appropriate entry **222**A in the IP address range hash table **220**, and setting the bit **232**A-**232**N corresponding to the particular list to "0" in the corresponding list bit mask **230**.

[0071] Various embodiments of the techniques described in **FIG. 3** enable the maintenance of an up-to-date aggregate list data structure that can be used to determine the reputation of a message sender.

[0072] **FIG. 4** is a flow diagram that depicts a method of determining the reputation of a message sender.

[0073] In one embodiment, the process of determining the reputation of a message sender is initiated by receiving a request for the reputation of an electronic message sender. In various embodiments, the request is received in extensible markup language (XML), hypertext markup language (HTML), formatted as a DNS request, or in any appropriate format. In various embodiments, the request is received via HTTP, HTTPS, TCP (transaction control protocol)/IP sockets, Universal Datagram Protocol (UDP) or via any other appropriate means. For example, a request for the reputation of an email sender could come in the form of a DNS request using TCP/IP or UDP.

[0074] As noted above, in one embodiment and in the examples used herein senders are identified by IP address. However, in other embodiments any other sender identification values may be used.

[0075] In step **410**, two or more lists are obtained from two or more list providers. In various embodiments, these lists are obtained using DNS zone transfers; database exports and later imports; obtaining files containing the lists via file transfer protocol (FTP), hypertext transfer protocol (HTTP), secure HTTP (HTTPS), or the rsync protocol; or any other appropriate means. For example, in the context of **FIG. 1**, two or more lists are obtained from two list providers **150***a* and **150***b*.

[0076] In step **420**, the lists that contain the sender are determined. In various embodiments, step **420** comprises parsing each list from each sender or querying an aggregate list, and aggregate list data structure, or other appropriate mechanism. For example, in the context of **FIG. 2**, determining if a particular list contains the IP address comprises accessing each IP address range hash table **220** for each length or key **212**A-**212**D in the bit length hash table **210** and determining whether the IP address falls into any IP address range of an entry **222**A-**222**N in the IP address range hash table **220** and checking to determine which bits **232**A-**232**N are set in the list bit mask **230** for each matching entry in the IP address range hash table **220**.

[0077] In order to determine whether an IP address is contained in a range represented in the IP address range hash table **220**, the first X significant bits of the IP address are compared to the first X significant bits of the IP address ranges in entries of the table, where X is the number of bits

defined by the corresponding key **212**A-**212**D of the bit length hash table **210**. In one embodiment, determining whether there is a corresponding entry **222**A-**222**N in the IP address range hash table **220** comprises determining whether a key **222**A-**222**N exists in the IP address range hash table **220** for the first X bits of the IP address.

[**0078**] In one embodiment, in order to determine which lists contain the IP address, the steps above are performed for each individual list separately or all lists are checked at once. In a related embodiment, there are two or more list bit masks **230** corresponding to matching entries **222**A-**222**N in two or more IP address range hash table **220** corresponding to two or more entries in the bit length hash table **210**. Further, determining which lists contain the IP address comprises performing the "or" operation on the two or more bit masks to result in creating a result bit mask. The result bit mask will have "1"s in any place that any individual list bit mask **230** has a "1" and will have a "0" only at those bits where no list bit mask **230** has a "1". In other embodiments, other logical or mathematical functions could be used to combine the list bit masks **230**, such as addition, weighted addition, bitwise averaging, bitwise exclusive or, or any other appropriate function. In one embodiment, an aggregate list bit mask is used to store which lists indicate the IP address of the sender.

[**0079**] In step **430**, a reputation score is determined based on which lists contain the sender. In various embodiments, the reputation score is determined as a weighted sum of the aggregate list bit mask or as a polynomial of the aggregate list bit mask. In one embodiment, determining the reputation score is based on which lists contain the IP address of the sender. Such an embodiment is depicted in and described with respect to **FIG. 6**.

[**0080**] Various embodiments of **FIG. 4** and the reputation score that is produced can be used to help estimate whether an electronic message from a message sender is unsolicited. An example of such a use is depicted in **FIG. 7**.

3.2 Adding Entries to an Aggregate Data Structure

[**0081**] **FIG. 5** is a flow diagram that depicts a process for adding entries from a list to an aggregate list data structure.

[**0082**] In step **510**, the next item in the list of items to be added is obtained. In one embodiment, the list of items to be added is associated with a particular list and the particular list is associated with a particular bit in each list bit mask. In one embodiment, if there are no more items in the list, then no more steps are taken. In various embodiments, obtaining the next item in the list comprises obtaining the next item from a structured list, obtaining the next item from a linked list, querying a data structure containing one or more items, or any appropriate means.

[**0083**] In step **520** a check is made to determine whether a corresponding entry exists in the bit length hash table. In various embodiments, this comprises determining the length of the item obtained in step **510**. For example, in the context of **FIG. 2**, the item obtained in step **510** could be "152.*.*.*" which corresponds to a length of 8 bits "/8". Determining whether an entry for "/8" exists in the bit length hash table **210** would then comprise determining whether there already exists a "/8" key **212**A-**212**D in the hash table.

[**0084**] If a corresponding entry does not exist, then an appropriate entry is added in step **530**. In various embodiments, adding an appropriate entry comprises adding an appropriate key to a bit length hash table or any appropriate action.

[**0085**] After an appropriate entry is added in step **530** or if an entry already exists for that range (step **520**), then a check is performed to determine whether the IP address range for the new entry already exists in the IP address range hash table. For example, in the context of **FIG. 2**, if the item obtained in step **510** is "152.*.*.*", a check is made to determine whether an entry **222**A-**222**N exists for "152.*.*.*" in the /8 IP address range hash table **220** corresponding to the "/8" key **212**D in the bit length hash table **210**.

[**0086**] If there is no corresponding entry **222**A-**222**N in the IP address range hash table **220**, then in step **550** an entry is added to the appropriate data structure corresponding to the item obtained in step **510**. In one embodiment, adding an entry comprises setting all the bits in the corresponding list bit mask **230** to zeros. For example, in the context of **FIG. 2**, if there is no entry for "152.*.*.*" in the IP address range hash table **220**, then an entry is made for "152.*.*.*" in step **550** and all bits **232**A-**232**N in the list bit mask **230** corresponding to the "152.*.*.*" are set to zero.

[**0087**] If an entry has been added or there is already a corresponding entry in the IP address range hash table, then in step **560**, the list bit mask corresponding to the IP address range hash table entry for the added item is altered to indicate the particular list. For example, in the context of **FIG. 2**, if the entry for "152.*.*.*" is added to the IP address range hash table **220** or the entry already existed in the IP address range hash table **220**, then in step **560** the bit in the list bit mask **230** corresponding to the list is set. For example, in the context of **FIG. 2**, the entry for "152.*.*.*" already exists and the bit in the list bit mask **230** corresponding to the list is set.

[**0088**] Various embodiments of **FIG. 5** enable the aggregate list data structure to be updated with new information.

3.3 Example Reputation Score Calculations

[**0089**] **FIG. 6** is a flow diagram that depicts an example embodiment of determining a reputation score based on which lists indicate the sender. **FIG. 6** will be described assuming that the sender is associated with an IP address. The techniques described herein, however, are in no way limited to use of IP address as an identifier of a sender. In other embodiments, the sender is identified by domain name, email address, geographical location, or any appropriate mechanism.

[**0090**] In step **610**, a score is obtained corresponding to each list. In one embodiment, this score is obtained by determining, for each blacklist **160**A, **160**B, whether the sender's IP address is in the particular list. If the IP address is indicated in the particular list, then the score for the list represents a certain percentage likelihood that the message is an unsolicited electronic message (often higher than 50%). If the IP address is not indicated in the particular list, then the score for the list still represents a certain percentage likelihood that the message is an unsolicited message (often less than 50%).

[**0091**] In one embodiment, this score is obtained by determining, for each "white" list, whether the sender's IP

address is in the particular list. A white list is a list of IP addresses and ranges that are believed to be associated with senders of legitimate electronic messages. If the IP address is indicated in the particular list, then the score for the list represents a certain percentage likelihood that the message is unsolicited (often less than 50%). If the IP address is not indicated in the particular list, then the score for the list represents a certain percentage likelihood that the message is unsolicited (often higher than 50%).

[0092] In other embodiments, a white list or blacklist will contain ranges of IP addresses and exceptions to those IP addresses, thereby including all IP addresses in a range except those that are excluded. In various embodiments, the white lists and blacklists contain integer or floating point values indicating scores for IP address ranges and IP addresses, and these scores are used to determine an aggregate score for an IP address with respect to the lists. In one embodiment, the aggregate list data structure **200** of **FIG. 2** is queried to determine which lists indicate the sender.

[0093] In step **620**, an aggregate score is generated based on the scores for each list determined in step **610**. In one embodiment, the score for each list is a percentage likelihood that a message is unsolicited and the aggregate score is an aggregate percentage likelihood that is generated based on the individual percentages likelihoods. In various embodiments, this aggregate percentage likelihood is based on a weighted average of the individual percentages likelihoods, a sum or product of the individual percentages likelihoods, a polynomial of the individual percentages likelihoods, or any appropriate calculation. In various embodiments, the aggregate percentage is based in part on the Chi Squared function over the probabilities, a Robinson calculation, a Bayes calculation, or any other appropriate mechanism. A particular embodiment of the Chi Squared function is depicted in the Python Programming Language (www.python.org) code of Appendix A.

[0094] In step **630**, the aggregate score is mapped to a normalized score. In one embodiment, the aggregate score is an aggregate percentage, and the normalized score is a mapped percentage that has the range from 0% to 100%, and step **630** is performed by mapping the aggregate percentage to the normalized range from 0% to 100%. In various embodiments, this mapping is linear, piecewise linear, cubic, polynomial, or uses any other appropriate function. In one embodiment, a piecewise linear method of mapping the aggregate function is used and comprises determining the known lowest possible probability (LP), the known average probability (AP), the known highest possible probability (HP), and linearly mapping percentages from LP to AP to 0% to 50% and percentages from AP to HP to 50% to 100%. In equation form, with aggregate probability represented as P, this can be represented as:

$$\text{Mapped Percentage } (MP) = \{\text{if } (P < AP);\ (P - LP) * 50 / (AP - LP)$$

$$\{\text{else};\ (P - AP) * 50 / (HP - AP) + 50.$$

[0095] For example, if LP is 30%, AP is 40% and HP is 80%, then percentages from 30% to 40% would map to 0% to 50%; and percentages from 40% to 80% would map to 50% to 100%. In such an example, 35% would map to 25% and 60% would map to 75%.

[0096] In related embodiments, LP is determined by performing the calculations of step **620** using the lowest possible score (e.g. percentage) for each of the lists, and HP is determined by performing the calculations of step **620** using the highest possible score (e.g. percentage) for each of the lists, and AP is determined by performing the calculations of step **620** using a random sample of possible values and averaging the result.

[0097] In step **640**, the normalized score is mapped to an output score. In one embodiment, a mapped percentage is mapped to an output (mapped) score. In various embodiments, this mapping is linear, piecewise liner, cubic, piecewise cubic, polynomial, or piecewise polynomial, exponential, piecewise exponential, or any appropriate mapping. In one embodiment, this mapping is performed by using a piecewise function such as:

$$\text{Mapped Score } (MS) = \{\text{if } MP < .5;\ (-\log(MP)/\log(2) - 1)/\text{lo_k}$$

$$\{\text{else};\ 1.0/\text{hi_k} * (1 - 1/\log(2) * \log(1/(1 - MP)),$$

where lo_k and hi_k are constants. It may be beneficial to use hi_k and lo_k values approximately in the range of 0.5 and 2.0. It may be beneficial to use hi_k and lo_k values approximately in the range of 0.6 and 1.0. Hi_k and lo_k may each have the same value or may have different values.

[0098] Various embodiments depicted in **FIG. 6** are examples of determining a reputation score for an electronic message sender based on which lists indicate the IP address of the sender. The various embodiments of **FIG. 6** perform step **430** of **FIG. 4**. A result of **FIG. 6** is determination of a composite score. In various embodiments of **FIG. 6**, some of the steps are not performed, and the composite score determined by the process of **FIG. 6** is the aggregate score of step **620**, the mapped score of step **630**, or the output score of step **640**.

3.4 Example Process for Estimating Whether a Message is Unsolicited

[0099] **FIG. 7** is a flow diagram that depicts a process for estimating whether a message is unsolicited. The process of **FIG. 7** may be implemented, for example, in the software or hardware of a reputation requestor **140**, e.g. a mail transfer agent, that uses a reputation score value to determine how to process messages.

[0100] When a message arrives at a mail transfer agent or other system, it has a sender associated with it a. The sender can be defined by any appropriate identification mechanism. In various other embodiments, the sender is identified by IP address, domain name, email address, geographical location, or any other appropriate mechanism. In the examples used to described **FIG. 7**, it will be assumed that the message sender is identified by IP address.

[0101] In step **710**, the reputation score of the message sender is obtained. In one embodiment, the process of **FIG. 4** is used to obtain the reputation score of the message sender.

[0102] In step **720**, the reputation score is compared to a first predefined threshold to determine whether it is worse than the predefined threshold. If the reputation score is

worse than the predefined threshold, then the message is indicated as unsolicited in step **730**. In various embodiments, if the message is indicated as unsolicited, the message is deleted, put in a trash folder, put in a "bulk mail folder", flagged to indicate that it is estimated as unsolicited, or any other appropriate action. After step **730** is performed, the process completes.

[**0103**] If the reputation score is not worse than a certain predefined threshold (step **720**), then a check is made to determine whether the reputation score is better than a second predefined threshold in step **740**. If the reputation score is better than a certain predefined threshold, then in step **750**, it is indicated that the message is estimated as valid. In various embodiments, indicating that the message is estimated as valid comprises sending the message to the recipient's inbox without further filtering, sending the message to the recipient's inbox after limited filtering, allowing the message to bypass to regular filtering, flagging the message as valid, or any appropriate action. After step **750** is performed, the process completes.

[**0104**] If the reputation score for the sender is not better than a second predefined threshold (step **740**), then in step **760** it is indicated that the message is not estimated as either valid or invalid. In various embodiments, indicating that the message is not estimated as either valid or invalid comprises applying filters to the message, forwarding the message to the recipient, not flagging the message as either valid or invalid, or any appropriate action.

[**0105**] Various embodiments of **FIG. 7** allow for the use of a reputation score of a message sender to aid in the detection of valid and unsolicited messages. Such embodiments can be beneficial in that they allow for more accurate and more efficient filtering of messages.

4.0 Implementation Mechanisms—Hardware Overview

[**0106**] **FIG. 8** is a block diagram that illustrates a computer system **800** upon which an embodiment of the invention may be implemented. Computer system **800** includes a bus **802** or other communication mechanism for communicating information, and a processor **804** coupled with bus **802** for processing information. Computer system **800** also includes a main memory **806**, such as a random access memory ("RAM") or other dynamic storage device, coupled to bus **802** for storing information and instructions to be executed by processor **804**. Main memory **806** also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor **804**. Computer system **800** further includes a read only memory ("ROM") **808** or other static storage device coupled to bus **802** for storing static information and instructions for processor **804**. A storage device **810**, such as a magnetic disk or optical disk, is provided and coupled to bus **802** for storing information and instructions.

[**0107**] Computer system **800** may be coupled via bus **802** to a display **812**, such as a cathode ray tube ("CRT"), for displaying information to a computer user. An input device **814**, including alphanumeric and other keys, is coupled to bus **802** for communicating information and command selections to processor **804**. Another type of user input device is cursor control **816**, such as a mouse, trackball, stylus, or cursor direction keys for communicating direction information and command selections to processor **804** and for controlling cursor movement on display **812**. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane.

[**0108**] The invention is related to the use of computer system **800** for electronic message delivery approaches. According to one embodiment of the invention, electronic message delivery approaches are provided by computer system **800** in response to processor **804** executing one or more sequences of one or more instructions contained in main memory **806**. Such instructions may be read into main memory **806** from another computer-readable medium, such as storage device **810**. Execution of the sequences of instructions contained in main memory **806** causes processor **804** to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

[**0109**] The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor **804** for execution. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical or magnetic disks, such as storage device **810**. Volatile media includes dynamic memory, such as main memory **806**. Transmission media includes coaxial cables, copper wire and fiber optics, including the wires that comprise bus **802**. Transmission media can also take the form of acoustic or light waves, such as those generated during radio wave and infrared data communications.

[**0110**] Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punchcards, papertape, any other physical medium with patterns of holes, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, a carrier wave as described hereinafter, or any other medium from which a computer can read.

[**0111**] Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to processor **804** for execution. For example, the instructions may initially be carried on a magnetic disk of a remote computer. The remote computer can load the instructions into its dynamic memory and send the instructions over a telephone line using a modem. A modem local to computer system **800** can receive the data on the telephone line and use an infrared transmitter to convert the data to an infrared signal. An infrared detector can receive the data carried in the infrared signal and appropriate circuitry can place the data on bus **802**. Bus **802** carries the data to main memory **806**, from which processor **804** retrieves and executes the instructions. The instructions received by main memory **806** may optionally be stored on storage device **810** either before or after execution by processor **804**.

[**0112**] Computer system **800** also includes a communication interface **818** coupled to bus **802**. Communication interface **818** provides a two-way data communication coupling to a network link **820** that is connected to a local network **822**. For example, communication interface **818**

may be an integrated services digital network ("ISDN") card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface **818** may be a local area network ("LAN") card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface **818** sends and receives electrical, electromagnetic or optical signals that carry digital data streams representing various types of information.

[**0113**] Network link **820** typically provides data communication through one or more networks to other data devices. For example, network link **820** may provide a connection through local network **822** to a host computer **824** or to data equipment operated by an Internet Service Provider ("ISP") **826**. ISP **826** in turn provides data communication services through the worldwide packet data communication network now commonly referred to as the "Internet"**828**. Local network **822** and Internet **828** both use electrical, electromagnetic or optical signals that carry digital data streams. The signals through the various networks and the signals on network link **820** and through communication interface **818**, which carry the digital data to and from computer system **800**, are exemplary forms of carrier waves transporting the information.

[**0114**] Computer system **800** can send messages and receive data, including program code, through the network(s), network link **820** and communication interface **818**. In the Internet example, a server **830** might transmit a requested code for an application program through Internet **828**, ISP **826**, local network **822** and communication interface **818**. In accordance with the invention, one such downloaded application provides for electronic message delivery approaches as described herein.

[**0115**] The received code may be executed by processor **804** as it is received, and/or stored in storage device **810**, or other non-volatile storage for later execution. In this manner, computer system **800** may obtain application code in the form of a carrier wave.

5.0 Extensions and Alternatives

[**0116**] In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

Appendix A

[**0117**] A.1 Function for Summing Terms for Chi Squared:

```
def chi2q(x2, v):
    if v and v % 2:
        raise "Error: v must be even in chi2q."
    m = x2/2.0
    term = math.exp(0 - m)
    sum = term
    for i in range (1, v/2):
        term *= m / i
        sum += term
    return sum < 1.0 and sum or 1.0
```

[**0118**] A.2 Function for Calculating Chi Squared Value for a List of Probabilities

```
def chi_squared_probs_combine(sorted):
    if not len(sorted):
        return .5
    H = 1.0
    S = 1.0
    Hexp = 0
    Sexp = 0
    for prob in sorted:
        S *= 1.0 - prob
        H *=prob
    if S < 1e-200:
        S, e = math.frexp(S)
        Sexp += e
    if H < 1e-200:
        H, e = math.frexp(H)
        Hexp += e
ln2 = math.log(2)
S = math.log(S) + Sexp * ln2
H = math.log(H) + Hexp * ln2
S = 1.0 - chi2q(-2.0 * S, 2 * len(sorted))
H = 1.0 - chi2q(-2.0 * H, 2 * len(sorted))
return ((S - H) + 1.0 ) /2.0
```

What is claimed is:

1. A method of determining a reputation of a message sender comprising the machine-implemented steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender; and

determining a reputation score for the message sender based on which lists of the two or more lists indicate the message sender.

2. The method of claim 1, wherein the method further comprises the step of storing information from the two or more lists in an aggregate list data structure, and wherein the step of determining what lists indicate the message sender comprises the step of querying the aggregate list data structure.

3. The method of claim 2, wherein a particular list is one of the two or more lists and the particular list contains one or more entries, and wherein the step of storing information from the two or more lists in the aggregate list data structure comprises the steps of:

determining the difference of the particular list with a previous version of the particular list;

storing entries of the particular list that were not in the previous version of the particular list in the aggregate list data structure; and

removing from the aggregate list data structure entries that are not in the particular list but were in the previous version of the particular list.

4. The method of claim 1, wherein the step of determining the reputation score comprises the steps of:

determining an individual score for each list of the two or more lists; and

determining an output score based on the individual score for each list in the two or more lists.

5. The method of claim 4, wherein the step of determining the output score comprises the steps of:

determining an aggregate score based on the individual score for each list of the two or more lists;

determining a normalized score based on the aggregate score; and

determining the output score based on the normalized score.

6. The method of claim 5, wherein the individual score for each list in the two or more lists each comprises an individual probability and a list of probabilities comprises the individual probability for each list in the two or more lists, and wherein the step of determining the aggregate score based on the individual score for each list of the two or more lists comprises performing a Chi Squared calculation on the list of probabilities.

7. The method of claim 1, wherein the method further comprises the step of receiving a request for the reputation of the message sender.

8. The method of claim 7, wherein the step of receiving the request for the reputation of the message sender comprises receiving a request formatted as a DNS request.

9. The method of claim 1, wherein the message sender is associated with a particular IP address and the step of determining what lists of the two or more lists indicate the message sender comprises determining for a particular list of the two or more lists whether the particular IP address of the message sender is contained in an IP address range indicated by the particular list.

10. The method of claim 1, further comprising the step of, if a particular list indicates an IP address range, setting a bit corresponding to the particular list in a particular list bit mask data structure corresponding to the IP address range.

11. The method of claim 10, wherein the step of setting the bit corresponding to the particular list is performed for each list of the two or more lists, and wherein sender corresponds to a particular IP address, the particular IP address is contained within a first IP address range that has associated with it a first list bit mask, the IP address is contained within a second IP address range associated with a second list bit mask, and the method further comprises the step of determining which lists of the two or more lists indicate the message sender by performing the steps of:

performing an or operation on the first list bit mask and second list bit mask to produce a third list bit mask; and

determining what bits are set in the third list bit mask.

12. A method comprising the machine-implemented steps of:

receiving a message from a message sender;

obtaining a reputation score of the message sender, wherein the reputation score of the message sender was determined by performing the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender;

determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender; and

if the reputation score is worse than a first predefined threshold, performing a specified action associated with responding to an unsolicited message.

13. The method of claim 12, wherein the step of performing the specified action comprises indicating that the message is unsolicited.

14. The method of claim 12, wherein the step of performing the specified action comprises deleting the message.

15. The method of claim 12, wherein the step of performing the specified action comprises moving the message into a trash message folder.

16. The method of claim 12, wherein the step of performing the specified action comprises moving the message into a bulk mail message folder.

17. The method of claim 12, wherein the step of performing the specified action comprises associating the message with a first flag, wherein the first flag indicates that the message is estimated to be unsolicited.

18. The method of claim 12, wherein the method further comprises the step of:

if the reputation score is better than a second predefined threshold, performing a second specified action associated with responding to messages that are not unsolicited, wherein the first predefined threshold is different from the second predefined threshold.

19. The method of claim 18, wherein the step of performing the second specified action comprises indicating that the message is valid.

20. The method of claim 18, wherein the message is associated with a message recipient, and wherein the step of performing the second specified action comprises sending the message to the message recipient.

21. The method of claim 18, wherein the step of performing the second specified action comprises performing one or more filter operations on the message.

22. The method of claim 18, wherein the step of performing the second specified action comprises associating the message with a second flag, wherein the second flag indicates that the message is estimated to be valid.

23. The method of claim 18, wherein the method further comprises the step of:

if the reputation score is better than the first predefined threshold and worse than the second predefined threshold, performing a third specified action.

24. The method of claim 23, wherein the step of performing the third specified action comprises indicating that the message has a first quality, where the first quality indicates that the message is not estimated as valid and the message is not indicated as invalid.

25. The method of claim 23, wherein the step of performing the third specified action comprises performing one or more filter operations on the message.

26. The method of claim 23, wherein the message is associated with a message recipient, and wherein the step of performing the third specified action comprises sending the message to the message recipient.

27. The method of claim 23, wherein the step of performing the third specified action comprises associating with the message a third flag, wherein the third flag indicates that the message is not estimated to be either valid or invalid.

28. The method of claim 12, wherein the method further comprises the step of sending a request for the reputation score of the message sender to a service for determining the

reputation of the message sender, and wherein the step of obtaining the reputation score of the message sender comprises receiving a response to the request for the reputation score of the message sender from the service for determining a reputation of the message sender.

29. The method of claim 28, wherein the step of sending the request for the reputation score of the message sender comprises sending a DNS request and receiving the response to the request for the reputation score of the message sender comprises receiving a DNS response.

30. A machine-readable medium carrying one or more sequences of instructions for determining a reputation of a message sender, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender; and

determining a reputation score for the message sender based on which lists of the two or more lists indicate the message sender.

31. A machine-readable medium as recited in claim 30, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of storing information from the two or more lists in an aggregate list data structure, and wherein the step of determining what lists indicate the message sender comprises the step of querying the aggregate list data structure.

32. A machine-readable medium as recited in claim 31, wherein a particular list is one of the two or more lists and the particular list contains one or more entries, and wherein the step of storing information from the two or more lists in the aggregate list data structure comprises the steps of:

determining the difference of the particular list with a previous version of the particular list;

storing entries of the particular list that were not in the previous version of the particular list in the aggregate list data structure; and

removing from the aggregate list data structure entries that are not in the particular list but were in the previous version of the particular list.

33. The machine-readable medium of claim 30, wherein the step of determining the reputation score comprises the steps of:

determining an individual score for each list of the two or more lists; and

determining an output score based on the individual score for each list in the two or more lists.

34. The machine-readable medium of claim 33, wherein the step of determining the output score comprises the steps of:

determining an aggregate score based on the individual score for each list of the two or more lists;

determining a normalized score based on the aggregate score; and

determining the output score based on the normalized score.

35. The machine-readable medium of claim 34, wherein the individual score for each list in the two or more lists each comprises an individual probability and a list of probabilities comprises the individual probability for each list in the two or more lists, and wherein the step of determining the aggregate score based on the individual score for each list of the two or more lists comprises performing a Chi Squared calculation on the list of probabilities.

36. The machine-readable medium of claim 30, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of receiving a request for the reputation of the message sender.

37. The machine-readable medium of claim 36, wherein the step of receiving the request for the reputation of the message sender comprises receiving a request formatted as a DNS request.

38. The machine-readable medium of claim 30, wherein the message sender is associated with a particular IP address and the step of determining what lists of the two or more lists indicate the message sender comprises determining for a particular list of the two or more lists whether the particular IP address of the message sender is contained in an IP address range indicated by the particular list.

39. The machine-readable medium of claim 30, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of, if a particular list indicates an IP address range, setting a bit corresponding to the particular list in a particular list bit mask data structure corresponding to the IP address range.

40. The machine-readable medium of claim 39, wherein the step of setting the bit corresponding to the particular list is performed for each list of the two or more lists, and wherein sender corresponds to a particular IP address, the particular IP address is contained within a first IP address range that has associated with it a first list bit mask, the IP address is contained within a second IP address range associated with a second list bit mask, and wherein the machine-readable medium further comprises instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of determining which lists of the two or more lists indicate the message sender by performing the steps of:

performing an or operation on the first list bit mask and second list bit mask to produce a third list bit mask; and

determining what bits are set in the third list bit mask.

41. A machine-readable medium carrying one or more sequences of instructions, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:

receiving a message from a message sender;

obtaining a reputation score of the message sender, wherein the reputation score of the message sender was determined by performing the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender;

determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender; and

if the reputation score is worse than a first predefined threshold, performing a specified action associated with responding to an unsolicited message.

42. The machine-readable medium of claim 41, wherein the step of performing the specified action comprises indicating that the message is unsolicited.

43. The machine-readable medium of claim 41, wherein the step of performing the specified action comprises deleting the message.

44. The machine-readable medium of claim 41, wherein the step of performing the specified action comprises moving the message into a trash message folder.

45. The machine-readable medium of claim 41, wherein the step of performing the specified action comprises moving the message into a bulk mail message folder.

46. The machine-readable medium of claim 41, wherein the step of performing the specified action comprises associating the message with a first flag, wherein the first flag indicates that the message is estimated to be unsolicited.

47. The machine-readable medium of claim 41, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of:

if the reputation score is better than a second predefined threshold, performing a second specified action associated with responding to messages that are not unsolicited, wherein the first predefined threshold is different from the second predefined threshold.

48. The machine-readable medium of claim 47, wherein the step of performing the second specified action comprises indicating that the message is valid.

49. The machine-readable medium of claim 47, wherein the message is associated with a message recipient, and wherein the step of performing the second specified action comprises sending the message to the message recipient.

50. The machine-readable medium of claim 47, wherein the step of performing the second specified action comprises performing one or more filter operations on the message.

51. The machine-readable medium of claim 47, wherein the step of performing the second specified action comprises associating the message with a second flag, wherein the second flag indicates that the message is estimated to be valid.

52. The machine-readable medium of claim 47, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of:

if the reputation score is better than the first predefined threshold and worse than the second predefined threshold, performing a third specified action.

53. The machine-readable medium of claim 52, wherein the step of performing the third specified action comprises indicating that the message has a first quality, where the first quality indicates that the message is not estimated as valid and the message is not indicated as invalid.

54. The machine-readable medium of claim 52, wherein the step of performing the third specified action comprises performing one or more filter operations on the message.

55. The machine-readable medium of claim 52, wherein the message is associated with a message recipient, and wherein the step of performing the third specified action comprises sending the message to the message recipient.

56. The machine-readable medium of claim 52, wherein the step of performing the third specified action comprises associating with the message a third flag, wherein the third flag indicates that the message is not estimated to be either valid or invalid.

57. The machine-readable medium of claim 41, further comprising instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of sending a request for the reputation score of the message sender to a service for determining the reputation of the message sender, and wherein the step of obtaining the reputation score of the message sender comprises receiving a response to the request for the reputation score of the message sender from the service for determining a reputation of the message sender.

58. The machine-readable medium of claim 57, wherein the step of sending the request for the reputation score of the message sender comprises sending a DNS request and receiving the response to the request for the reputation score of the message sender comprises receiving a DNS response.

59. An apparatus for determining a reputation of a message sender, comprising:

means for obtaining two or more lists from two or more list providers;

means for determining which lists of the two or more lists indicate the message sender; and

means for determining a reputation score for the message sender based on which lists of the two or more lists indicate the message sender.

60. The apparatus of claim 59, further comprising means for storing information from the two or more lists in an aggregate list data structure, and wherein the means for determining what lists indicate the message sender comprises means for querying the aggregate list data structure.

61. The apparatus of claim 60, wherein a particular list is one of the two or more lists and the particular list contains one or more entries, and wherein the means for storing information from the two or more lists in the aggregate list data structure comprises:

means for determining the difference of the particular list with a previous version of the particular list;

means for storing entries of the particular list that were not in the previous version of the particular list in the aggregate list data structure; and

means for removing from the aggregate list data structure entries that are not in the particular list but were in the previous version of the particular list.

62. The apparatus of claim 59, wherein the means for determining the reputation score comprises:

means for determining an individual score for each list of the two or more lists; and

means for determining an output score based on the individual score for each list in the two or more lists.

63. The apparatus of claim 62, wherein the means for determining the output score comprises:

means for determining an aggregate score based on the individual score for each list of the two or more lists;

means for determining a normalized score based on the aggregate score; and

means for determining the output score based on the normalized score.

64. The apparatus of claim 63, wherein the individual score for each list in the two or more lists each comprises an individual probability and a list of probabilities comprises the individual probability for each list in the two or more lists, and wherein the means for determining the aggregate score based on the individual score for each list of the two or more lists comprises means for performing a Chi Squared calculation on the list of probabilities.

65. The apparatus of claim 59, further comprising means for receiving a request for the reputation of the message sender.

66. The apparatus of claim 65, wherein the means for receiving the request for the reputation of the message sender comprises means for receiving a request formatted as a DNS request.

67. The apparatus of claim 59, wherein the message sender is associated with a particular IP address and the means for determining what lists of the two or more lists indicate the message sender comprises means for determining for a particular list of the two or more lists whether the particular IP address of the message sender is contained in an IP address range indicated by the particular list.

68. The apparatus of claim 59, further comprising means for setting a bit corresponding to a particular list in a particular list bit mask data structure corresponding to an IP address range if the particular list indicates the IP address range.

69. The apparatus of claim 68, wherein the means for setting the bit corresponding to the particular list comprises means for setting the bit corresponding to each list of the two or more lists, and wherein sender corresponds to a particular IP address, the particular IP address is contained within a first IP address range that has associated with it a first list bit mask, the IP address is contained within a second IP address range associated with a second list bit mask, and the apparatus further comprises means for determining which lists of the two or more lists indicate the message sender, and the means for determining which lists of the two or more lists indicate the message sender comprises:

means for performing an or operation on the first list bit mask and second list bit mask to produce a third list bit mask; and

means for determining what bits are set in the third list bit mask.

70. An apparatus comprising:

means for receiving a message from a message sender;

means for obtaining a reputation score of the message sender, wherein the reputation score of the message sender was determined by performing the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender;

determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender; and

means for performing a specified action associated with responding to an unsolicited message, if the reputation score is worse than a first predefined threshold.

71. The apparatus of claim 70, wherein the means for performing the specified action comprises means for indicating that the message is unsolicited.

72. The apparatus of claim 70, wherein the means for performing the specified action comprises means for deleting the message.

73. The apparatus of claim 70, wherein the means for performing the specified action comprises means for moving the message into a trash message folder.

74. The apparatus of claim 70, wherein the means for performing the specified action comprises means for moving the message into a bulk mail message folder.

75. The apparatus of claim 70, wherein the means for performing the specified action comprises means for associating the message with a first flag, wherein the first flag indicates that the message is estimated to be unsolicited.

76. The apparatus of claim 70, wherein the apparatus further comprises:

means for performing a second specified action associated with responding to messages that are not unsolicited, if the reputation score is better than a second predefined threshold, wherein the first predefined threshold is different from the second predefined threshold.

77. The apparatus of claim 76, wherein the means for performing the second specified action comprises means for indicating that the message is valid.

78. The apparatus of claim 76, wherein the message is associated with a message recipient, and wherein the means for performing the second specified action comprises means for sending the message to the message recipient.

79. The apparatus of claim 76, wherein the means for performing the second specified action comprises means for performing one or more filter operations on the message.

80. The apparatus of claim 76, wherein the means for performing the second specified action comprises means for associating the message with a second flag, wherein the second flag indicates that the message is estimated to be valid.

81. The apparatus of claim 76, wherein the apparatus further comprises:

means for performing a third specified action, if the reputation score is better than the first predefined threshold and worse than the second predefined threshold.

82. The apparatus of claim 81, wherein the means for performing the third specified action comprises means for indicating that the message has a first quality, where the first quality indicates that the message is not estimated as valid and the message is not indicated as invalid.

83. The apparatus of claim 81, wherein the means for performing the third specified action comprises means for performing one or more filter operations on the message.

84. The apparatus of claim 81, wherein the message is associated with a message recipient, and wherein the means for performing the third specified action comprises means for sending the message to the message recipient.

85. The apparatus of claim 81, wherein the means for performing the third specified action comprises means for associating with the message a third flag, wherein the third flag indicates that the message is not estimated to be either valid or invalid.

86. The apparatus of claim 70, wherein the apparatus further comprises means for sending a request for the

reputation score of the message sender to a service for determining the reputation of the message sender, and wherein the means for obtaining the reputation score of the message sender comprises means for receiving a response to the request for the reputation score of the message sender from the service for determining a reputation of the message sender.

87. The apparatus of claim 86, wherein the means for sending the request for the reputation score of the message sender comprises means for sending a DNS request and the means for receiving the response to the request for the reputation score of the message sender comprises means for receiving a DNS response.

88. An apparatus for determining a reputation of a message sender, comprising:

a network interface that is coupled to a data network for receiving one or more packet flows therefrom;

a processor;

one or more stored sequences of instructions which, when executed by the processor, cause the processor to carry out the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender; and

determining a reputation score for the message sender based on which lists of the two or more lists indicate the message sender.

89. The apparatus of claim 88, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of storing information from the two or more lists in an aggregate list data structure, and wherein the step of determining what lists indicate the message sender comprises the step of querying the aggregate list data structure.

90. The apparatus of claim 89, wherein a particular list is one of the two or more lists and the particular list contains one or more entries, and wherein the step of storing information from the two or more lists in the aggregate list data structure comprises the steps of:

determining the difference of the particular list with a previous version of the particular list;

storing entries of the particular list that were not in the previous version of the particular list in the aggregate list data structure; and

removing from the aggregate list data structure entries that are not in the particular list but were in the previous version of the particular list.

91. The apparatus of claim 88, wherein the step of determining the reputation score comprises the steps of:

determining an individual score for each list of the two or more lists; and

determining an output score based on the individual score for each list in the two or more lists.

92. The apparatus of claim 91, wherein the step of determining the output score comprises the steps of:

determining an aggregate score based on the individual score for each list of the two or more lists;

determining a normalized score based on the aggregate score; and

determining the output score based on the normalized score.

93. The apparatus of claim 92, wherein the individual score for each list in the two or more lists each comprises an individual probability and a list of probabilities comprises the individual probability for each list in the two or more lists, and wherein the step of determining the aggregate score based on the individual score for each list of the two or more lists comprises performing a Chi Squared calculation on the list of probabilities.

94. The apparatus of claim 88, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of receiving a request for the reputation of the message sender.

95. The apparatus of claim 94, wherein the step of receiving the request for the reputation of the message sender comprises receiving a request formatted as a DNS request.

96. The apparatus of claim 88, wherein the message sender is associated with a particular IP address and the step of determining what lists of the two or more lists indicate the message sender comprises determining for a particular list of the two or more lists whether the particular IP address of the message sender is contained in an IP address range indicated by the particular list.

97. The apparatus of claim 88, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of, if a particular list indicates an IP address range, setting a bit corresponding to the particular list in a particular list bit mask data structure corresponding to the IP address range.

98. The apparatus of claim 97, wherein the step of setting the bit corresponding to the particular list is performed for each list of the two or more lists, and wherein sender corresponds to a particular IP address, the particular IP address is contained within a first IP address range that has associated with it a first list bit mask, the IP address is contained within a second IP address range associated with a second list bit mask, and wherein the apparatus further comprises one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of determining which lists of the two or more lists indicate the message sender by performing the steps of:

performing an or operation on the first list bit mask and second list bit mask to produce a third list bit mask; and

determining what bits are set in the third list bit mask.

99. An apparatus for determining a reputation of a message sender, comprising:

a network interface that is coupled to a data network for receiving one or more packet flows therefrom;

a processor;

one or more stored sequences of instructions which, when executed by the processor, cause the processor to carry out the steps of:

receiving a message from a message sender;

obtaining a reputation score of the message sender, wherein the reputation score of the message sender was determined by performing the steps of:

obtaining two or more lists from two or more list providers;

determining which lists of the two or more lists indicate the message sender;

determining the reputation score for the message sender based on which lists of the two or more lists indicate the message sender; and

if the reputation score is worse than a first predefined threshold, performing a specified action associated with responding to an unsolicited message.

100. The apparatus of claim 99, wherein the step of performing the specified action comprises indicating that the message is unsolicited.

101. The apparatus of claim 99, wherein the step of performing the specified action comprises deleting the message.

102. The apparatus of claim 99, wherein the step of performing the specified action comprises moving the message into a trash message folder.

103. The apparatus of claim 99, wherein the step of performing the specified action comprises moving the message into a bulk mail message folder.

104. The apparatus of claim 99, wherein the step of performing the specified action comprises associating the message with a first flag, wherein the first flag indicates that the message is estimated to be unsolicited.

105. The apparatus of claim 99, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of:

if the reputation score is better than a second predefined threshold, performing a second specified action associated with responding to messages that are not unsolicited, wherein the first predefined threshold is different from the second predefined threshold.

106. The apparatus of claim 105, wherein the step of performing the second specified action comprises indicating that the message is valid.

107. The apparatus of claim 105, wherein the message is associated with a message recipient, and wherein the step of performing the second specified action comprises sending the message to the message recipient.

108. The apparatus of claim 105, wherein the step of performing the second specified action comprises performing one or more filter operations on the message.

109. The apparatus of claim 105, wherein the step of performing the second specified action comprises associating the message with a second flag, wherein the second flag indicates that the message is estimated to be valid.

110. The apparatus of claim 105, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of:

if the reputation score is better than the first predefined threshold and worse than the second predefined threshold, performing a third specified action.

111. The apparatus of claim 110, wherein the step of performing the third specified action comprises indicating that the message has a first quality, where the first quality indicates that the message is not estimated as valid and the message is not indicated as invalid.

112. The apparatus of claim 110, wherein the step of performing the third specified action comprises performing one or more filter operations on the message.

113. The apparatus of claim 110, wherein the message is associated with a message recipient, and wherein the step of performing the third specified action comprises sending the message to the message recipient.

114. The apparatus of claim 110, wherein the step of performing the third specified action comprises associating with the message a third flag, wherein the third flag indicates that the message is not estimated to be either valid or invalid.

115. The apparatus of claim 99, further comprising one or more stored sequences of instructions which, when executed by the one or more processors, cause the one or more processors to carry out the step of sending a request for the reputation score of the message sender to a service for determining the reputation of the message sender, and wherein the step of obtaining the reputation score of the message sender comprises receiving a response to the request for the reputation score of the message sender from the service for determining a reputation of the message sender.

116. The apparatus of claim 115, wherein the step of sending the request for the reputation score of the message sender comprises sending a DNS request and receiving the response to the request for the reputation score of the message sender comprises receiving a DNS response.

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